

What is claimed is:

1. A method of replenishing hydrogen in a hydrogen fuel cell stack,
comprising:

providing a source of hydrogen for the hydrogen fuel cell stack;

5 providing a hydrogen fuel cell stack having an inlet for the introduction of
hydrogen and an outlet for the removal of hydrogen;

providing a hydrogen delivery and recovery sub-system for supplying hydrogen
to the inlet of the hydrogen fuel cell stack and recovering unused hydrogen from the
outlet of the hydrogen fuel cell stack, the hydrogen delivery and recovery sub-system

10 including a hermetically sealed regenerative pump to pump hydrogen through the
hydrogen delivery and recovery sub-system and hydrogen fuel cell stack;

supplying hydrogen to the hydrogen delivery and recovery sub-system with the
source of hydrogen;

pumping hydrogen through the hydrogen delivery and recovery sub-system to
15 and from the hydrogen fuel cell stack using the hermetically sealed regenerative pump.

2. The method of claim 1, wherein the hermetically sealed regenerative
pump includes an inner chamber and one or more passages within the inner chamber
that hydrogen flows through, at least one of the one or more passages including a relief
hole to balance the pressure between an inside of the one or more passages with the
20 relief hole and the inner chamber.

3. The method of claim 1, wherein the hermetically sealed regenerative
pump includes an impeller, a motor with a rotating shaft to rotate the impeller, and an
anti-rotation mechanism to prevent the shaft from rotating relative to the impeller.

4. The method of claim 3, wherein the impeller includes an incurved channel and the shaft includes an incurved channel alignable with each other to form a bore, and the anti-rotation mechanism includes a rod disposed in the bore formed by the aligned incurved channels of the impeller and the shaft.

5 5. The method of claim 1, further including a motor to operate the hermetically sealed regenerative pump and a current controller to set and maintain the current of the motor, and the method further including using the current controller to run the motor at a constant power level, preventing overheating of the motor.

10 6. An anode sub-system of a hydrogen-based fuel cell system, comprising:
a hydrogen storage tank;
an anode of a hydrogen fuel cell stack;
and a hydrogen delivery and recovery sub-system including a hermetically sealed regenerative pump to pump unused hydrogen from the anode of the hydrogen fuel cell stack through the hydrogen delivery and recovery sub-system to and from the
15 hydrogen fuel cell stack.

7. The anode sub-system of claim 6, wherein the hermetically sealed regenerative pump includes an inner chamber and one or more passages within the inner chamber that hydrogen flows through, at least one of the one or more passages including a relief hole to balance the pressure between an inside of the one or more
20 passages with the relief hole and the inner chamber.

8. The anode sub-system of claim 6, wherein the hermetically sealed regenerative pump includes an impeller, a motor with a rotating shaft to rotate the

impeller, and an anti-rotation mechanism to prevent the shaft from rotating relative to the impeller.

9. The anode sub-system of claim 8, wherein the impeller includes an incurved channel and the shaft includes an incurved channel alignable with each other
5 to form a bore, and the anti-rotation mechanism includes a rod disposed in the bore formed by the aligned incurved channels of the impeller and the shaft.

10. The anode sub-system of claim 6, wherein the hermetically sealed regenerative pump includes a motor to operate the hermetically sealed regenerative pump and a current controller to set and maintain a constant power level in the motor,
10 preventing overheating of the motor.

11. A hermetically sealed regenerative pump of an anode sub-system of a hydrogen-based fuel cell system, comprising:

a hermetically sealed enclosure including an inner chamber;
a motor disposed within the inner chamber of the hermetically sealed enclosure
15 and including a rotatable shaft;
an impeller connected to the rotatable shaft and rotatable therewith to pump hydrogen through the anode sub-system of the hydrogen-based fuel cell system;
one or more passages within the inner chamber that hydrogen flows through, at least one of the one or more passages including a relief hole to balance the pressure
20 between an inside of the one or more passages with the relief hole and the inner chamber.

12. The hermetically sealed regenerative pump of claim 11, further including an anti-rotation mechanism to prevent the shaft from rotating relative to the impeller.

13. The hermetically sealed regenerative pump of claim 12, wherein the impeller includes an incurved channel and the shaft includes an incurved channel alignable with each other to form a bore, and the anti-rotation mechanism includes a rod disposed in the bore formed by the aligned incurved channels of the impeller and the
5 shaft.

14. The hermetically sealed regenerative pump of claim 11, further including a current controller to set and maintain a constant power level in the motor, preventing overheating of the motor.